DIVISION 16

ELECTRICAL SYSTEMS

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. General:

1. Materials and equipment shall comply with all requirements of the contract documents. Materials furnished by the contractor shall be new, the standard products of manufacturers regularly engaged in the production of such materials, and of the manufacturer's latest designs that comply with the specification requirements. If material and equipment requirements conflict, the order of precedence for selection shall be as follows: in accordance with specification section "Summary of Work"; and then in continuing order of precedence, Military Specifications, Federal Specifications, NFPA publications, IEEE standards, UL standards and NEMA standards. Wherever standards have been established by Underwriters' Laboratories, Inc., the material shall bear the UL label.

B. This Section includes the following electrical materials and methods:

1. Supporting devices for electrical components.
2. Electrical demolition.
3. Cutting and patching for electrical construction.
4. Touchup painting.

C. Applicable provisions of this Project include the following:

1. Remove existing electrical system equipment in accordance with demolition drawings and specifications.
2. Provide equipment, wiring devices, and electrical connections required for installation of electrical equipment.
3. Provide wiring for power and lighting.
4. Provide grounding..

D. Space requirements: Electrical equipment sizes indicated on the Drawings are generally based on specified manufacturer.

1. Verify that the equipment proposed will fit in the space indicated on the Drawings. Coordinate building dimensions with architectural and structural drawings. Equipment furnished and installed under other Sections of this specification shall be coordinated with electrical equipment installed under this Section.
2. Maintain clearances required by NEC around electrical equipment. Establish the exact location of electrical equipment based on the actual field verified dimensions of equipment furnished.

1.2 REFERENCE STANDARDS

A. General: Comply with the standards in effect as of the date of the Contract Documents as applicable to the extent specified in Division 16. The rules, regulations and reference specifications enumerated in these specifications shall be considered as minimum requirements. Adherence to other standards shall not relieve the contractor from furnishing and installing higher grades of materials and workmanship when so required by this specification. Adherence to this specification shall not relieve the Contractor from furnishing and installing higher grades of materials and workmanship when so required by the contract Drawings or special contracts provisions. This specification shall govern when conflicts occur. The documents referenced in Article 1.1, paragraph A, sub-paragraph 1, of this Section.

B. American National Standards Institute (ANSI)

1.	A13.1	Scheme for the Identification of Piping Systems.

C. American Society for Testing and Materials (ASTM)

1.	A36	Standard Specification for Carbon Structural Steel.
2.	A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

D. Federal Aviation Administration (FAA)

1.	STD-019e	Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment.
2.	C1217f	Electrical Work, Interior.
3.	C1391a	Installation and Splicing of Underground Cables.

E. Institute of Electrical and Electronic Engineers (IEEE)

1.	519	Recommended Practices and Requirements for Harmonic Control and Electrical Power Systems.

F. National Electrical Contractors Association (NECA)

1. Standard of Installation

G. National Electrical Manufacturers Association (NEMA)

1.	WC 5	Thermoplastic-Insulated Wires and Cable for the Transmission and Distribution of Electrical Energy.
2.	WC7	Cross Linked Thermosetting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

H. National Fire Protection Association (NFPA)

1.	70	National Electrical Code (NEC)

I. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7 Description and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

J. Underwriters Laboratories (UL)

1. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.3 SUBMITTALS

A. Product Data for each type of product specified.

B. Shop Drawings detailing fabrication, installation, and location of supports, seismic bracing, and anchorage for electrical items.

C. Project Record Documents: Maintain at the job site a separate set of white prints of the Contract Documents for the purpose of recording the system and dimension changes of those portions of work in which actual construction is significantly at variance with the Contract Documents. The Contractor shall record changes for both GFE and Contractor provided equipment. Upon acceptance of the project, submit documents to the COR, with verification of data accuracy. Mark the Drawings with colored pencil. Prepare the Drawings as the work progresses. Upon completion of work submit Drawings clearly indicating the following:

1. Locations of devices, conduits, equipment and other pertinent items.
2. Schematic and interconnection wiring diagrams of the completed power system incorporating the data derived from the equipment shop drawings. The drawings shall be detailed to wire and terminal block numbers, conductor color coding, device designations, locations, and reflect identifications established at the site.

D. Samples of color, lettering style, and other graphic representation required for each identification product for Project.

E. Operation and Maintenance Instructions:

1. Reference Material: Provide three copies of operating and maintenance instructions, equipment service manuals, catalog cuts and illustrations as described herein. The Operations and Maintenance (O&M) data shall be placed in suitable binders for use by maintenance personnel. The material shall include equipment model and serial numbers, performance characteristics, and power and utility requirements. Final acceptance of this equipment is contingent upon submission of required documents to, and approval by, the COR prior to equipment or facility turnover.
2. Minimum Data Required: Operating and maintenance instructions shall contain the following minimum data and shall comply with submittal requirements specified in individual Sections of the Specifications. Training on the operation and maintenance of special equipment shall be conducted by a certified technician from the manufacturer.

a. Operating instructions shall include illustrations and explanations for controls, initial set points, and startup and shutdown procedures for both normal and emergency conditions.
b. Maintenance instructions shall include periodic inspection and lubrication requirements, and when applicable, equipment performance verification requirements. Include a list of required tools and equipment to maintain the system.
c. Troubleshooting and fault diagnosis data shall list trouble symptoms, instructions necessary to determine cause of trouble and the action required to restore equipment to operating condition.
d. Repair instructions shall include equipment disassembly, repair, replacement, and reassembly. Checkout or test data shall also be provided. Reprogramming instructions shall be provided for equipment having a programmable memory. Repacking instructions shall be provided for sending equipment to the manufacturer or to a repair depot for repairs.
e. A parts list shall be furnished that includes part names and part numbers that are shown on illustrations or tables. The parts list shall identify the actual manufacturer of the part, replacement cost, and shall also contain a notation of identifying products as Commercial grade for common non-special design hardware.
f. The instructions shall contain a list of spare parts recommended by the equipment manufacturer to support the operation of the equipment for a one year time period. Provide names, addresses, and telephone numbers of all service organizations that supply repair parts for the system or systems to be furnished.
g. The O&M data shall include overhaul instructions that are required to return the equipment to full operational capability in the event that the machinery stops working properly.
h. The O&M data shall contain as appropriate, the following:

    1) Wiring diagrams
    2) Electrical schematics
    3) Wire terminal assignments
    4) Equipment layouts
    5) Record Electrical Drawings, modified to record actual conditions and modifications, including dimensions
    6) Approved Shop Drawings

i. After final tests and adjustments have been completed, fully instruct the COR and other personnel, as directed by the COR, in details of operation and maintenance of special equipment, including control system, and fire alarm system, as installed. Submit outline of proposed instruction course, scheduled during a 3 week period, 21 days prior to start, for approval by the COR.

F. Operating Tests: An interim operating and performance test shall be performed for each major equipment item after installation is complete and before the item is placed in service. After mechanical systems have been completely installed and balanced, test each system for proper operation. Tests shall be conducted in the presence of the COR under design conditions to

ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of the systems. Special tests on individual systems are specified under individual sections. Tests shall be scheduled and approved in writing by COR at least 10 working days prior to conducting tests. Contractor shall demonstrate, to the COR's satisfaction, proper operation of control devices by simulating actual operating conditions. Devices tested shall include, but not be limited to, flow and pressure controls, temperature controls, and system interlocks and alarms.

1.4 QUALITY ASSURANCE

A. All materials procured and installed under this specification shall be in accordance with FAA-C-1217f and FAA-STD-019e.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

D. Summary: Submit a summary of the Electrical Test Report and Motor Test Report, noting deviations from requirements listed below:

1. Maximum plus or minus five percent variation between nominal system voltage and no load voltage and between no load and full load voltage;
2. Variation between motor average phase current and measured individual phase currents does not exceed the manufacturer's specified limits; and;
3. Maximum plus or minus ten percent variation between average phase current and measured individual phase currents for panel-boards.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.

C. Coordinate installing required supporting devices and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work.

E. Coordinate connecting electrical service to components furnished under other Sections.

F. Not used.

G. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

H. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

I. Interruption of Power: Contractor is advised that this facility includes a fully operational Air Traffic Control Center (ARTCC). The electrical power system is comprised of the types: critical, essential, and building service. Work shall be performed on the three types as indicated on drawings. Unscheduled interruptions of the electrical service may cause aircraft accidents and loss of life. Contractor is advised that failure to establish and maintain proper means and methods during the Work, resulting in accidents or loss of life, may result in charges of criminal negligence.

1. Work requiring a temporary or permanent de-energizing of critical, essential, and building service power systems shall be scheduled and approved in writing by the COR at least 21 calendar days in advance of performance of work.
2. Work may not commence until written authorization is received from the COR.
3. Unscheduled interruptions of power shall not be allowed at any time.
4. Only Government personnel are authorized to energize or de-energize equipment, to operate circuit breakers, switches, or fuses in this facility. Only the utility company shall be authorized to turn on, or turn off, the commercial power to this facility.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. Provide channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners to provide secure support from the building structure for electrical components.

1. Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.
2. Metal Items for Damp Locations: Hot-dip galvanized steel, except as otherwise indicated.

B. Provide steel channel supports with 9/16-inch diameter holes at a maximum of 8 inches on center, in at least 1 surface.

1. Fittings and accessories to mate and match with channels and from same manufacturer.

D. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with welded spiral seams or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:

    a. 3-inch and smaller: 20-gage.
    b. 4-inch to 6-inch: 16-gage.
    c. over 6-inch: 14-gage.
2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

E. Expansion Anchors: Carbon-steel wedge or sleeve type.

F. Toggle Bolts: All-steel spring head type.

G. Powder-Driven Threaded Studs: Not Allowed.

H. Fasteners for plastic-laminated and metal signs: Self-tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts and flat end lock washers.

I. Supplementary Structural Supports: ASTM A 36 steel shapes

1. Supports shall be designed and installed to withstand the local code equivalent of a minimum UBC Seismic Zone 4 force.
2. Provide the installation of supplementary structural supports required for attachment of hangers and other devices supporting electrical equipment and conduits.
3. Members welded to main structural members shall be equal to the specification for the main structural member.
4. Size support members for their actual loads without excessive deflection and with consideration for rigidity under vibration.

2.2 TOUCHUP PAINT

A. For Equipment: Provided by equipment manufacturer and selected to match equipment finish.

B. For Non-equipment Surfaces: Matching type and color of undamaged, existing adjacent finish.

C. For Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

A. All materials and equipment shall be installed in accordance with the Contract Drawings, and with FAA-C-1217f and FAA-STD-019e.

B. Where manufacturers recommended installation methods conflict with contract requirements, difference shall be resolved by the COR

C. The installation shall be accomplished by skilled workers regularly engaged in this type of work. Where required by local regulation, the workers shall be properly licensed.

D. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.

E. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.

F. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

H. Removal and Relocation of the Existing Work: The Drawings indicate the extent of modifications to existing work. Electrical equipment which is part of, or operates in conjunction with, relocated mechanical equipment shall be disconnected, relocated and reinstalled with mechanical equipment. Equipment and materials indicated to be relocated will be inspected by COR prior to removal. The relocation and reinstallation of mechanical equipment is specified in applicable Mechanical Sections of the Specifications. The work shall be performed with care in order not to damage the existing equipment and materials. Repair or replace equipment and materials damaged. Notify the COR prior to removal of equipment and materials indicated on the Drawings to be removed and relocated.

I. Removal of Polychlorinated Biphenyls (PCB) Contaminated Ballasts: Lighting ballasts used in this facility may contain PCBs as indicated in drawings. PCB contaminated ballasts designated to be removed shall be disposed of in accordance with Section 02070.

3.2 ELECTRICAL SUPPORTING METHODS

A. Damp Locations: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Conform to manufacturer's recommendations for selecting supports.

3.3 INSTALLATION

A. The rules, regulations, and reference documents indicated shall be considered as minimum requirements and shall not relieve the Contractor from furnishing and installing higher grades of materials and workmanship than are specified or when required by the Contract Drawings. Equipment shall be installed in a manner to provide proper working spaces, access, and space for removal of the equipment as required.

B. Contract Drawings: Where the Drawings schematically indicate the work, diagrammatically or otherwise, furnish and install equipment, material, and labor for a complete and proper installation. Ensure that electrical and communications Work is coordinated and compatible with Architectural, Mechanical and Structural Work.

C. Firestopping: Apply to cable and raceway penetrations of fire-rated floor and wall assemblies. Perform firestopping as specified in Section 07270, "Fire-Stopping" to reestablish the original fire-resistance rating of the assembly at the penetration.

D. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure in accordance with Paragraph 2.1, "Supporting Devices", and with National Electrical Code (NEC) requirements. Install hangers and supports to withstand forces for the UBC Seismic Zone indicated.

E. Install identification devices where required in accordance with the requirements of Section 16195, "Electrical Identification." Engrave nameplates as indicated up to a maximum of three lines. Identification and name plates shall be in accordance with FAA C-1217f, paragraphs 4.16 and 4.16.1.

F. Wiring Methods.

1. General: All wiring shall consist of insulated copper conductors installed in metallic raceways, unless otherwise specified.
2. Conductor routing: Panelboards, disconnect switches, etc., shall not be used as raceway for conductor routing other than conductors that originate or terminate in these enclosures. Isolated ground conductors will be allowed to traverse these enclosures.
3. Conductor separation: Power conductors shall be routed separately from all other conductor types. Provide separate raceways to route power conductors and other conductors. Provide a metallic divider between the power conductors and the other conductors in the same raceway, if same raceway is used.

    a. Power cables of less than 600 volts may be installed in the same duct; however, 480/277V power cables shall be in separate raceways from 208/120V power cables.
    b. Power cables of less than 600 volts shall not be installed in the same duct with control, telephone, or signal type cables.

4. Neutral conductor: Shared/common neutrals shall not be permitted, i.e., each over current device shall have its own separate neutral conductor. Neutral conductor size shall not be less than the respective feeder or phase conductor sizes.
5. Ground conductor: Shared/common grounding conductors shall not be permitted, i.e., each over current device shall have its own separate ground conductor.

3.4 DEMOLITION

A. Where electrical work to remain is damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work Indicated to Be Demolished: Remove exposed electrical installation in its entirety.

C. Abandoned Work: Remove electrical conductors in their entirety. Cap and patch surface to match existing finish.

D. Removal: Remove demolished material from the Project site.

E. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.5 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.

B. Repair disturbed surfaces to match adjacent undisturbed surfaces.

3.6 TOUCHUP PAINTING

A. Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

3.7 FIELD TESTING

A. General: Perform the tests specified and other tests necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each system. Repair or replace equipment that does not meet test requirements and retest. Tests shall be scheduled and approved in writing by COR at least 21 working days prior to conducting tests. Unless otherwise indicated, the contractor shall furnish all test instruments, materials and labor necessary to perform tests designated in Division 16 Sections. All tests shall be performed in the presence of the COR. All instruments shall have been calibrated within a period of two years preceding testing. Calibrations shall be traceable to applicable industry recognized standards.

B. An interim operating and performance test shall be performed for each major equipment item after installation is complete and before the item is placed in service. After mechanical systems have been completely installed and balanced, test each system for proper operation. Tests shall be conducted in the presence of the COR under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of the systems. Special tests on individual systems are specified under individual sections. Provide 21 days written notice to the COR for major tests. Contractor shall

demonstrate, to the COR's satisfaction, proper operation of control devices by simulating actual operating conditions. Devices tested shall include, but not be limited to, flow and pressure controls, temperature controls, and system interlocks and alarms.

C. After final tests and adjustments have been completed, fully instruct the COR and other personnel as directed by the COR in details of operation and maintenance of electrical equipment, including control systems and fire alarm system as installed.

D. Motor Insulation Resistance Test: Motors shall be tested for ground or short circuits after installation, but before start up. Windings shall test free from short circuits and grounds. Minimum insulation resistance for motors, phase to phase and phase to ground shall not be less than 30 mega ohm measured with a 500 volt DC insulation resistance tester. Apply the test voltage for at least one minute after the reading has stabilized.

E. Load Balancing: After the Contractor Acceptance Inspection (CAI) of electrical systems, redistribute the loads where there is a greater than a twenty percent difference between readings in two or more phases, in accordance with Section 16470, "Panelboards."

F. Complete the Electrical Test Report, Form 16050-1 included as Attachment No. 1. Provide the requested information for each panelboard and its power supply conductors. Perform insulation resistance tests in compliance with Section 16120, "Wire and Cables", on wires including the neutral before connection to source and to loads.

G. Complete the Motor Test Report, Form 16050-2 included as Attachment No. 2. Provide the requested information for each motor.

*****END OF SECTION 16050*****

ATTACHMENT NO. 1

Electrical Test Report

Project Name _____ Date _____ Sheet No. ___ of ___
Project No._____ Address_____

SERVICE TRANSFORMER SIZE									
NL SERVICE VOLTAGE									
FL SERVICE VOLTAGE									
PANEL OR SWBD SERVED FROM									
PANEL OR SWITCHBOARD									
LOCATION									
MANUFACTURER									
TYPE									
FEEDER O C PROTECTION									
FEEDER CONDUCTOR SIZE									
GROUND CONDUCTOR SIZE									
MEASURED CONDITIONS	PHASE			PHASE			PHASE		
	A	B	C	A	B	C	A	B	C
NO LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER CURRENT									
CONDUCTOR INSUL RESISTANCEØ AB									
CONDUCTOR INSUL									

RESISTANCEØ BC									
CONDUCTOR INSUL RESISTANCEØ CA									
CONDUCTOR INSUL RESISTANCE TO GROUND									
NEUTRAL INSUL RES TO GR W/GR CONN REMOVED									

ATTACHMENT NO. 2

Motor Test Report

Project Name _____ Date _____ Sheet No. ___ of ___
Project No._____ Address_____

DESTINATION		
LOCATION		
HORSEPOWER		
NEMA STARTER SIZE		
STARTER MFG. & CAT. NO.		
HEATER CAT. NO.		
MAXIMUM HEATER AMPS		
CONDUCTOR SIZE		
GROUND COND. SIZE		
SERVED FROM PNL OR MCC.		

MEASURED CONDITIONS	PHASE			PHASE		
	A	B	C	A	B	C
ACTUAL MOTOR CURRENT						
NAMEPLATE MOTOR CURRENT						
NO LOAD VOLTAGE						
FULL LOAD VOLTAGE						
CONDUCTOR INSUL. RESISTANCEØ AB						
CONDUCTOR INSUL. RESISTANCEØ BC						
CONDUCTOR INSUL. RESISTANCEØ CA						
CONDUCTOR INSUL.						

RESISTANCE TO GR.						